dpr

Department of Pesticide Regulation

Paul E. Helliker
Director

Gray Davis
Governor

Winston H. Hickox
Secretary, California Environmental Protection Agency

MEMORANDUM

TO: Don Weaver, Senior Environmental Research Scientist
Environmental Monitoring and
Pest Management

FROM: Craig Nordmark, Associate Environmental Research Scientist Craig Nordmark
Environmental Monitoring and
Pest Management
(916) 324-4138

DATE: September 15, 2000

SUBJECT: PRELIMINARY RESULTS OF ACUTE AND CHRONIC TOXICITY TESTING OF SURFACE WATER MONITORED IN THE SACRAMENTO RIVER WATERSHED, WINTER 1999-2000

SCOPE OF THIS MEMORANDUM

The purpose of this memorandum is to provide results of water sampling conducted on the Sacramento River by the Department of Pesticide Regulation (DPR). Data included here are from the period December 7, 1999 to March 10, 2000 and encompass results from both chemical analyses conducted by the California Department of Food and Agriculture (CDFA) Center for Analytical Chemistry and bioassays conducted by the California Department of Fish and Game (DFG). This memorandum summarizes the fourth-year of a five-year study, begun in 1996, designed to monitor the occurrence of toxicity and dormant spray insecticides in the Sacramento River watershed. An in-depth interpretation of the data is not included here but will be provided in the final report, which will include data from all five years of the study.

BACKGROUND

The Sacramento River is the largest river in California both in volume of water and in drainage area (Friebel et al., 1995) (Figure 1). From Mount Shasta in the north to the Sacramento-San Joaquin Delta in the south, the river flows for 327 miles and drains approximately 27,000 square miles including agricultural, urban and undeveloped land areas (Domagalski and Brown, 1994). The primary source of water entering the system is surface runoff from the Sierra Nevada Mountains to the east and Cascade Range to the north (CSLC, 1993). Runoff from rain events occurring in the Sacramento Valley and Coastal Range Mountains provide short term increases in river flow. Seasonal rains occur from October to March with little significant rain from June to September. River flow during the summer is composed of dam releases of snow-melt water for agricultural, urban, recreational and wildlife purposes.

In the Sacramento Valley, the organophosphorus insecticides diazinon and methidathion are the primary dormant season insecticides used on stone fruit and nut crops (DPR 1994; DPR 1995; DPR 1996;). This dormant spray application period coincides with the bulk of the seasonal rainfall, providing the potential for these pesticides to wash off target areas and migrate with surface runoff to the Sacramento River. Runoff from orchard areas west of the Sacramento River chiefly flows into the Colusa Basin Drain, which enters the Sacramento River at Knights Landing (Figure 2). Runoff from dormant spray areas east of the Sacramento River principally flows into Butte Creek, which has been engineered to drain into the Sutter Bypass via the Butte Slough (Figure 3). Runoff from the west side of the Feather River also drains into the Sutter Bypass. During periods of normal flow, the Sutter Bypass enters the Sacramento River via the Sacramento Slough at Karnak. During periods of high flow, the Sutter Bypass channel fills completely with runoff from this area plus water diverted from the Sacramento River. This flow merges with the Feather River eight miles prior to entering the Sacramento River, forming a two-mile wide channel that inundates the Sacramento Slough. During floods, a large portion of the flows of the Sacramento River and the Sutter Bypass/Feather River will be diverted into the Yolo Bypass. Runoff from areas east of the Feather River drains into the Feather River above Nicolaus.

Previous studies of the Sacramento River by the U.S. Geological Survey (USGS) and DPR have shown that most diazinon detections were observed during the dormant spray season (MacCoy et al., 1995; Ganapathy, 1997). The USGS study also detected low levels of methidathion during this season. In a California Regional Water Quality Control Board (CVRWQCB) study (Foe and Sheipline, 1993), acute toxicity to *Ceriodaphnia dubia* in conjunction with high diazinon and methidathion concentrations was found at Gilsizer Slough, which drains some of the area west of the Feather River and flows into the Sutter Bypass (Figure 2).

During the course of the Sacramento River monitoring by DPR, both the primary acute and chronic toxicity monitoring sites have been relocated based on factors discovered in the previous years sampling. Acute toxicity monitoring has been conducted at the Sutter Bypass at Karnak, the Sutter Bypass at Kirkville Road and at Wadsworth Canal. The Karnak site was the primary site, with Kirkville Road being used as a backup when the primary site was flooded for the first two years of the study. (Note: the Kirkville Road site was erroneously referred to as the Sacramento Avenue site in the first year of the study. The backup Sutter Bypass site is now referred to by the more geographically correct nomenclature of Kirkville Road.) Wadsworth Canal became the primary acute site in the 1998-99 dormant season, however, monitoring in the Sutter Bypass for water chemistry has been continued. Chronic toxicity monitoring has been conducted at the Bryte water intake tower and at Alamar Marina on the Sacramento River. The Bryte site was utilized for the 1996-97 dormant season. All subsequent Sacramento River monitoring has been at Alamar Marina. Diazinon has remained the most common herbicide detected at all of the monitoring sites.

During the winter of 1996-97, no acute toxicity was found at the Sutter Bypass site and no chronic toxicity or reproductive impairment was found at the Sacramento River (Nordmark et al., 1998). Two diazinon pulses were detected in the Sutter Bypass, one in late January and one in late February (Figure 4). The latter pulse lasted up to two weeks and did not appear to be related to any storm event. Diazinon was detected in 44% of the samples taken from the Sutter Bypass at levels up to 0.09 μg/L. A single diazinon pulse, lasting up to eight days, was detected in the Sacramento River in late-January. Diazinon was detected in 16% of the samples from the Sacramento River at Bryte, with levels as high as 0.07 μg/L. Methidathion was detected in one sample each from the Sutter Bypass and from the Sacramento River. This study was conducted during a dormant season marked by heavy rains and significant flooding during January, which delayed the start of sampling, with virtually no rain after January 29.

During 1997-1998 no acute toxicity was found at the Sutter Bypass site and no chronic toxicity or reproductive impairment was found at the Sacramento River (Nordmark, 1998). Acute toxicity monitoring continued in the Sutter Bypass but chronic toxicity monitoring in the Sacramento River was changed to Alamar Marina. The original Sacramento River site at Bryte was abandoned due to problems with the sampler snagging on underwater obstructions. Inputs between the Alamar and Bryte sites are minimal. Diazinon detections in the Sutter Bypass were sporadic, occurring throughout January and early February (Figure 4). Diazinon was detected in 30% of the Sutter Bypass samples, with a peak concentration of 0.1 μg/L. Two diazinon pulses were observed on the Sacramento River. The first, at the end of January, lasted 3-4 days; the second pulse lasted up to 21 days from early to late February. Diazinon was detected in 40% of the samples collected from the Sacramento River, with levels as high as 0.17 μg/L. Methidathion was detected in a single sample from the Sacramento River. This study was also conducted during a wet dormant season. River and bypass flows were high and rain events occurred regularly until the last week of February.

During 1998-1999, sampling was conducted at three sites, a new acute toxicity site at Wadsworth Canal, and the Sutter Bypass and the Sacramento River sites monitored in the previous year (Nordmark, 1999). It was determined from the monitoring results of the previous two years that the Sutter Bypass site did not typically represent a small watershed during the winter months as desired for the study. Wadsworth Canal at South Butte Road, a tributary of the Sutter Bypass, was chosen as the new acute toxicity monitoring site. Monitoring at the Sutter Bypass site was continued, however, only chemical analyses were performed on the samples collected there. Multiple occurrences of acute toxicity were found at the new site in conjunction with high levels of diazinon. One Sacramento River sample demonstrated chronic toxicity but it was not associated with any insecticide detections. Diazinon was detected in 85% of the samples collected at Wadsworth Canal with a peak concentration of 1.6 μg/L (Figure 5), 45% of the Sutter Bypass samples with a peak concentration of 0.11 μg/L, and in none of the Sacramento River samples (Figure 4). Methidathion was detected once at Wadsworth Canal. Wadsworth Canal samples were acutely toxic 40% of the time. Diazinon was present in all of the toxic samples, with 0.2 μg/L corresponding to a rough threshold where toxic effects occurred. This study was again conducted during a wet dormant season. River discharge was high in early December but declined until a sharp rise in mid-January, remaining high until the end of the study. Bypass discharge was also high in early December but did not rise substantially until early February. There was a rain event in early December with regular rain events beginning in mid-January through the end of February.

The objective of this study was to continue monitoring the occurrence of aquatic toxicity, both acute and chronic, in portions of the Sacramento River watershed. Additionally, all water samples were analyzed for a number of organophosphate and carbamate insecticides, and certain soil applied herbicides, that have historically been applied in the study (Table 1). Wadsworth Canal, a tributary of the Sutter Bypass which does not contain major inputs from municipal or industrial sources, was selected for acute toxicity testing to *C. dubia* and chemical analysis. The potential for chronic toxicity was investigated in the Sacramento River at Alamar Marina, which is downstream from dormant spray insecticide inputs into the watershed, yet above input from the American River. Pesticide levels alone were monitored in the Sutter Bypass. A companion study was conducted to monitor pesticide levels and toxicity in the San Joaquin River watershed (Jones, 2000) and these results will be presented in a separate memorandum. Long-term monitoring of acute and chronic toxicity in these watersheds will help scientists at DPR evaluate the effectiveness of programs designed to decrease the runoff of dormant spray insecticides.

MATERIALS AND METHODS

Study Site Description

Wadsworth Canal

The Wadsworth Canal site is located 3.5 miles above the confluence with the Sutter Bypass, at a weir, just upstream of South Butte Road. This location continues to flow during periods of high discharge in the bypass and it receives runoff from the southern quarter of Butte County and northern Sutter County between the Feather River and the Sutter Buttes (Figure 3). The area is largely agricultural with numerous orchards to the east along the Feather River. Wadsworth Canal drains into the Sutter Bypass just above the Sutter National Wildlife Refuge and combines the flows of several streams and manmade canals. Seven samples had to be collected from an alternate site at the Butte House Road Bridge, 1.3 miles upstream of the primary site, due to the heavy accumulation of debris at the weir or difficulty gaging discharge at the weir during very high flows. There are no inputs in the area between the two sites on Wadsworth Canal.

Sutter Bypass

We collected samples for chemical analysis from a small bridge across the western channel of the Sutter Bypass at the Karnak Pumping Station, just prior to the Sacramento Slough. This allowed us to obtain results that were comparable to the previous three years of dormant spray monitoring. Acute toxicity testing was not conducted at this site since it was performed on water from the smaller Wadsworth Canal location. The Sutter Bypass receives runoff water from most of the agricultural areas between the Sacramento and Feather Rivers (Figure 3). Previous studies have indicated the potential for high concentrations of pesticides in this area (Wofford and Lee, 1995). The alternate site for monitoring, when the Karnak site became flooded, was on the western edge of the Sutter Bypass at Kirkville Road, approximately nine miles upstream from Karnak. Both sites had been used the first three years for our toxicity study. During the 1999-2000 season, the Sutter Bypass at Karnak site was accessible for sampling through February 9th all other samples were collected at Kirkville Road.

Sacramento River

The chronic toxicity monitoring site was located on the right bank of the Sacramento River at the Alamar Marina Dock, nine miles below the confluence of the Feather River. This site receives discharge from all major agricultural tributaries but is above the confluence of the largely non-agricultural American River and the discharge of urban runoff from the cities of Sacramento and West Sacramento (Figure 3). This site was the same as the previous two years.

Sample Collection

Background sampling was conducted during the week of December 7, 1999, prior to the onset of the dormant spray season. Dormant season sampling began on January 3rd and continued through March 10, 2000, when no more dormant spray applications were reported.

Chemical analyses were performed on each water sample collected. Selected organophosphate and carbamate insecticides and soil applied herbicides were analyzed in three separate analyses with diazinon being analyzed in a fourth analysis (Table 1). Insecticides included in our analyses were chosen based on pesticide use reports indicating historical use during the dormant spray season in the Central Valley, previous detections in the watershed, the availability of analytical methods in the organophosphate or carbamate screens and to standardize analyses between the Sacramento and San Joaquin River studies. Herbicides included in our analyses were chosen based on historical use during the year in the Central Valley and the availability of analytical methods in a single screen.

Acute toxicity tests were performed twice per week, with samples collected on Monday and Wednesday. One chronic toxicity test was conducted weekly using water samples collected on Monday, Wednesday, and Friday. Water collected on Monday was used to begin the chronic toxicity tests. Water collected on Wednesday and Friday was used to renew chronic test water (see below).

Water samples were collected at the Alamar, Karnak and Wadsworth Canal sites, from as close to center channel as possible, using a depth-integrated sampler (D-77) with a 3-liter Teflon® bottle and nozzle. This method was often unsuitable for use in the Sutter Bypass at Kirkville Road site. When the site was flooded, samples were collected by wading into the stream and utilizing a 1-liter bottle on the end of a 4-meter pole to collect subsurface grab samples.

Nine 1-liter splits were required for each sampling event. Approximately 12 liters of water were collected and composited in a stainless steel 10-gallon (38-liter) milk can. The composited sample was placed on wet ice for transportation back to the West Sacramento warehouse for splitting. All samples were split on the day of collection into 1-liter amber glass bottles, with Teflon® lined caps, using a (USGS designed) Geotech® 10-port splitter. One pair of 1-liter split samples from the Wadsworth Canal and Sacramento River sites were submitted for toxicity testing. Four 1-liter samples from each site were submitted for chemical analyses: one each for the organophosphate, carbamate, diazinon and herbicide analyses. Two 1-liter backups were stored at West Sacramento and 1-liter was used for acidification purposes.

Samples designated for organophosphate and carbamate chemical analysis were preserved by acidification with 3N hydrochloric acid to a pH of between 3.0 to 3.5. Most organophosphate and carbamate pesticides are sufficiently preserved at this pH (Ross et al., 1996). Diazinon, however, rapidly degrades under acidic conditions and therefore was analyzed from a separate, unacidified, sample. Herbicide samples are stable without acidification and were thus not acidified. Samples were stored in a 4° C refrigerator until transported to the appropriate laboratory (on wet ice) for analysis. All primary samples were delivered to the testing laboratory within 24 hours of collection.

Environmental Measurements

Water quality parameters measured *in situ* included temperature, pH, electrical conductivity (EC), and dissolved oxygen (DO). Water pH was measured using a Sentron® (model 1001) pH meter. EC was measured using an Orion® conductivity-salinity meter (model 140). Water temperature and DO were measured using a YSI dissolved oxygen meter (model 57). Additionally, ammonia, alkalinity and hardness were measured by the DFG

Aquatic Toxicity Laboratory upon the delivery of the toxicity samples. Total ammonia was measured with an Orion® multi-parameter meter (model 290A) fitted with an Orion® ammonia ion selective electrode (model 95-12). Totals of alkalinity and hardness were measured with a Hach® titration kit.

Precipitation and discharge information were gathered for the study area. Precipitation data were averaged from two sites to approximate rainfall in the Sacramento Valley. The sites were located at a Department of Forestry station near Chico and a National Weather Service station at the Sacramento Post Office (stations CHI and SPO, respectively). Discharge was measured at the Wadsworth Canal each time a sample was collected. Discharge from the Butte-Slough near Meridian and the Tisdale Bypass gages were used to provide flow estimates for both Sutter Bypass sites. Discharge from the Verona USGS gaging station was used to estimate flow for the Sacramento River at Alamar Marina. The Verona site captures all major inputs to the Sacramento River above the sampling site. All precipitation and discharge data were taken from provisional, DWR, National Weather Service, USGS, and Department of Forestry information and is subject to revision. Further refinements of flow data at each site will be investigated for the final report as more information becomes available. This information will be used to follow annual changes in chemical concentrations with respect to fluctuations in flow and will also be useful for modeling efforts, should they be undertaken.

Chemical Analysis and Toxicity Testing

Chemical Analyses

Pesticide analyses of water samples were performed by the CDFA Center for Analytical Chemistry. The organophosphate insecticides were analyzed using gas chromatography (GC) and a flame photometric detector (FPD). The carbamate insecticides and the herbicides were analyzed using high performance liquid chromatography (HPLC), post column-derivatization and a fluorescence detector. The herbicides were analyzed by HPLC with a UV detector, and GC with a nitrogen phosphorus detector (NPD). The pesticides and reporting limits are listed in Table 1. Details of chemical analytical methods will be provided in the final report.

Quality control (QC) for the chemistry portion of this study was in accordance with Standard Operating Procedure QAQC001.00 (DPR, 1996) and consisted of a continuing QC program, plus the submission of 12 rinse blanks of the splitting equipment and 26 blind spikes submitted for the Sacramento and San Joaquin studies combined. Continuing QC results for each of the analytical screens are presented in Tables 2 through 6. Study 184 and 185 refer to the Sacramento and San Joaquin River studies, respectively. There were no detections of any pesticides in any of the

12 rinse blank samples. The 26 blind spikes, submitted along with the field samples from the two studies for analysis, contained 34 chemical analytes. More detailed quality control data, including method development, the establishment of control limits and spike recoveries, will be included in the final report.

Toxicity Tests

Acute toxicity testing was conducted by the DFG Aquatic Toxicity Laboratory following current U.S. Environmental Protection Agency (U.S. EPA) procedures using the cladoceran *Ceriodaphnia dubia* (U.S. EPA, 1993). Acute toxicity was determined using a 96-hour, static-renewal bioassay in undiluted sample water. One test was invalid due to low control sample survival however survival in the sample was 95%. The test was not restarted. Chronic toxicity was determined using a static-renewal 7-day bioassay of undiluted sample water with *C. dubia* and followed current U.S. EPA guidelines (U.S. EPA, 1994). Test organisms used in chronic testing were placed in sample water on day one of testing, with test water replenished on days three and five. One chronic toxicity control sample had low offspring per surviving adult and one had too high a mortality. None of these tests were restarted, however, since there was no indication of reduced survival or reproduction in the corresponding sample. All acute and chronic tests commenced and renewal water was used within 36 hours. Data were reported as percent survival for both acute and chronic tests and the average number of offspring per adult for the chronic tests. More complete information on chemical analytical and bioassay methods will be provided in the final report.

RESULTS

Environmental Measurements

Wadsworth Canal

Figure 6 presents the data for pH, ammonia, DO, temperature, EC, alkalinity and hardness for the Wadsworth Canal site. Ammonia levels were below the detection limit of 50 µg/L in all samples. pH values ranged from 7.0 to 8.2. Water temperature ranged from 8.2 to 14.6°C, DO ranged from 7.0 to 11.0 mg/L and EC ranged from 136 to 552 µS/cm. Alkalinity ranged from 54 to 250 mg/L and hardness ranged from 50 to 198 mg/L.

Sutter Bypass

Figure 7 presents the data for pH, DO, temperature, and EC for the Sutter Bypass sites. pH values ranged from 6.9 to 8.0. Water temperature ranged from 7.5 to 11.9° C, DO ranged from 6.1 to 10.4 mg/L and EC ranged from 100 to 404 µS/cm. Ammonia, alkalinity and hardness were not measured.

Sacramento River

Figure 8 presents the data for pH, DO, temperature, EC, alkalinity and hardness for the Sacramento River at Alamar Marina site. Ammonia levels remained below the detection limit of 50 µg/L for all samples. pH values ranged from 6.9 to 7.9. Water temperature ranged from 8.3 to 11.7°C, DO ranged from 8.8 to 11.2 mg/L and EC ranged from 100 to 169 µS/cm. Alkalinity were between 42 and 72 mg/L and hardness ranged from 36 to 70 mg/L.

Figure 9A presents precipitation averaged for two stations in the Sacramento Valley and discharge for the Sacramento River and the Sutter Bypass. Wadsworth Canal discharge is not presented in the figure, because it is at least an order of magnitude lower than at the other two sites. Measured discharge at Wadsworth Canal is included in Table 7. All discharge data presented in Figure 9 are based on preliminary data and are approximate as all inputs and diversions were not gaged and many gages are not accurately calibrated at extreme flows (personal communication: Steven Graham, DWR Surface Water Unit). The estimated discharge in the Sutter Bypass peaked at 67,000 cfs and the discharge in the Sacramento River at Verona peaked at 69,000 cfs. Inputs from sources such as Gilsizer Slough would increase the Sutter Bypass discharges presented here, but during high bypass flows these inputs would be insignificant. Water did not begin flowing through the Tisdale Weir into the Sutter Bypass until January 25. Peak river and bypass levels occurred in conjunction with a storm event in mid-February. Measured discharge at Wadsworth Canal peaked at 679 cfs in late-February. This dormant season was extremely dry through the middle of January. Rainfall after this point was above normal yielding an overall average precipitation year by the end of the dormant season. Total two-station-average rainfall for the season was 18.7 inches.

Chemical Concentrations and Toxicity Data

Wadsworth Canal

Diazinon was detected in 13 (59%) of the 22 samples collected from the Wadsworth Canal (Table 7). Diazinon was first detected on January 24 and continued to be detected in every sample through March 6. Diazinon levels ranged from 0.05 to 2.7 µg/L. Methidathion was detected 7 (32%) times, always in conjunction with diazinon. Methidathion levels ranged from 0.055 to 1.21 µg/L. Carbaryl was detected once on February 14 at 0.092 µg/L. This is the first time that carbaryl has been detected in the Sacramento watershed during the 4 years of dormant season monitoring.

Herbicide residues were detected in 16 of the 22 samples (73%), including in one background sample. Diuron was the most commonly detected herbicide with residues being detected 14 times at a maximum concentration of 0.85 µg/L. Simazine was detected 12 times with a maximum concentration of 0.4 µg/L. Bromacil was detected four times and hexazinone three times. The highest concentrations for these herbicides were 0.73, and 0.58 µg/L for bromacil and hexazinone, respectively. All four of these herbicides were present in 3 (14%) of the samples.

Nine of the 22 samples were acutely toxic to *C. dubia* (Table 7). Complete mortality was observed in seven of the samples and two samples had statistically significant reductions in survival. Diazinon was detected in all of the samples that demonstrated significant mortality but was also detected in 4 samples that did not show significant mortality. Once again this year, a diazinon concentration of roughly 0.2 µg/L appeared to correspond to a threshold where toxic effects occurred. Possible relationships between the occurrence of pesticides and aquatic toxicity will be investigated in the final report.

Sutter Bypass

Diazinon was detected in 4 of the 22 samples (18%) collected in the Sutter Bypass (Table 8). Diazinon was first detected at Karnak on January 31 at 0.04 µg/L. Diazinon continued to be detected in the Sutter Bypass until February 9, at levels ranging from 0.04 to 0.09 µg/L. Diuron was detected three times (14%) with a maximum concentration of 0.11 µg/L. Bromacil and simazine were detected once (5%) on January 26 at concentrations of 0.95 and 0.12 µg/L, respectively. Diuron was also present in the January 26 sample. No other insecticides or herbicides were detected.

Sacramento River

Diazinon was detected in 2 of the 33 samples (6%) collected from the Sacramento River at Alamar Marina (Table 8) with a maximum concentration of 0.06 µg/L. Diuron was detected in 16 samples (48%) with highest observed concentration of 0.22 µg/L. No other pesticides were detected.

Except for the January 17-21 samples, no chronic toxicity test had less than 90% survival and all produced between 15 and 45 offspring per adult female at the end of the test. One control had a 70% survival (80% survival is required for a valid test) and fecundity varied between 12.5 and 46 offspring (15 offspring are required for a valid test) (Table 8). The January 17-21 test had a 60% survival in the sample, however, this was not statistically different than the 80% survival in the corresponding control. Diuron was detected in the second and third water collections for this test at 0.16 and 0.05 µg/L concentrations, respectively. No other pesticides were detected in this sample. Statistical analysis of survival and reproduction data will be included in the final report.

References

California State Lands Commission (CSLC), 1993. California's rivers-A public trust report. Second Edition. CSLC, Sacramento, California.

Central Valley Regional Water Quality Control Board. 1994. Water Quality Control Plan (Basin Plan), Central Valley Region, Sacramento River and San Joaquin River Basins. Sacramento, California.

Domagalski, J., and L.R. Brown. 1994. The Sacramento Basin Fact Sheet, U.S. Geological Survey. National Water Quality Assessment (NAWQA) Program. Sacramento, California.

Department of Pesticide Regulation. 1993. Pesticide Use Report. Sacramento, California.

Department of Pesticide Regulation. 1994. Pesticide Use Report. Sacramento, California.

Department of Pesticide Regulation. 1995. Pesticide Use Report. Sacramento, California.

Department of Pesticide Regulation. 1996. Pesticide Use Report. Sacramento, California.

Department of Pesticide Regulation. 1996. Standard Operating Procedure Number QAQC001.00: Chemistry Laboratory Quality Control. Environmental Hazards Assessment Program, California Environmental Protection Agency. Sacramento, California.

Foe, C. and R. Sheipline, 1993. Pesticides in Surface Water From Applications on Orchards and Alfalfa During the Winter and Spring of 1991-92. California Regional Water Quality Control Board, Central Valley Region, Sacramento, California. February 1993.

Friebel M.F., K.L. Markham, S.W. Anderson and G.L. Rockwell, 1995. Water Resources Data, California, Water Year 1994. Volume 4. U.S. Geological Survey Water-Data Report CA-94-4. Sacramento, California

Ganapathy, C., C. Nordmark, K. Bennett, A. Bradley, H. Feng, J. Hernandez, and J. White. 1997. Temporal Distribution of Insecticide Residues in Four California Rivers. Department of Pesticide Regulation, Sacramento, California. December 1997. EH97-06

Ganapathy, C., 1998. Study 179: Protocol for Monitoring of Acute and Chronic Toxicity in the San Joaquin River Watershed: Winter 1998-99. Department of Pesticide Regulation, Sacramento, California. November, 1998.

Jones, D., 2000. Study 185: Protocol for Monitoring of Acute and Chronic Toxicity in the San Joaquin River Watershed: Winter 1999-2000. Department of Pesticide Regulation, Sacramento, California. September, 2000.

MacCoy, D., K.L. Crepeau, and K.M. Kuivila. 1995. Dissolved pesticide data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-94. U.S. Geological Survey Rep. 95-110. U.S. Gov. Print. Office, Washington DC.

Nordmark, C.E., K.P. Bennett, H. Feng, J. Hernandez, and P. Lee, 1998. Occurrence of Aquatic Toxicity and Dormant-Spray Pesticide Detections in the Sacramento River Watershed, Winter 1996-97. Department of Pesticide Regulation, Sacramento, California. February, 1998. EH98-01

Nordmark, C.E., 1998. Preliminary Results of Acute and Chronic Toxicity Testing of Surface Water Monitored in the in the Sacramento River Watershed: Winter 1997-98. Memorandum to Don Weaver, Environmental Hazards Assessment Program, Department of Pesticide Regulation, Sacramento, California. July, 1998.

Nordmark, C.E., 1999. Preliminary Results of Acute and Chronic Toxicity Testing of Surface Water Monitored in the in the Sacramento River Watershed: Winter 1998-99. Memorandum to Don Weaver, Environmental Hazards Assessment Program, Department of Pesticide Regulation, Sacramento, California. May, 1999.

Ross, L.J., R. Stein, J. Hsu, J. White, and K. Hefner, 1996. Distribution and Mass Loading of Insecticides in the San Joaquin River, California. Winter 1991-92 and 1992-93. Environmental Hazards Assessment Program. Department of Pesticide Regulation, Sacramento, California. EH96-02

Wofford, P.L. and P. Lee, 1995. Results for Monitoring for the Herbicide MCPA in Surface Water of the Sacramento River Basin. Environmental Hazards Assessment Program. Department of Pesticide Regulation, Sacramento, California. EH95-11

U.S. Environmental Protection Agency. 1993. Methods for measuring the acute toxicity of effluents and receiving waters to freshwater and marine organisms. 4th ed. EPA/600/4-90/027F. August 1993.

U.S. Environmental Protection Agency. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms. 3rd ed. EPA-600-4-91-002. July 1994.

Table 1. California Department of Food and Agriculture, Center for Analytical Chemistry organophosphate and carbamate insecticide and triazine herbicide screens for the Sacramento River toxicity monitoring study.

Organophosphate Pesticides in Surface Water by GC **Method: GC/FPD**		**N-Methyl Carbamate in Surface Water by HPLC** *Method: HPLC/Post Column-fluorescence*		**Herbicides in Surface Water by HPLC** **Method: HPLC/UV detector and GC/NPD**	
Compound	**Reporting Limit (µg/L)**	**Compound**	**Reporting Limit (µg/L)**	**Compound**	**Reporting Limit (µg/L)**
Chlorpyrifos	0.04	Carbaryl	0.05	Atrazine	0.05
Diazinon[1]	0.04	Carbofuran	0.05	Bromacil	0.05
Dimethoate (Cygon)	0.05			Diuron	0.05
Fonofos	0.05			Cyanazine	0.2
Malathion	0.05			Hexazinone	0.2
Methidathion	0.05			Metribuzin	0.2
Methyl parathion	0.05			Prometon	0.05
Phosmet	0.05			Prometryn	0.05
				Simazine	0.05

1 Diazinon was analyzed from a separate, unpreserved, split sample. Other OP and CB chemical samples were preserved with 3N HCl to a pH of 3-3.5 to retard analyte degradation. See text.

Table 2. Blind Spike Recoveries for the Sacramento and San Joaquin River Studies.

Extraction Date	Study Number[a]	Sample Number	Screen	Pesticide	Spike Level	Recovery	Percent Recovery	Exceed CL[b]
1/11/00	184	107	OP	Fonofos	0.2	0.152	76.0	LCL
				Phosmet	0.4	0.435	109	
1/13/00	185	169	OP	Dimethoate	0.2	0.225	112.5	
				Methidathion	0.1	0.11	110.0	
1/18/00	184	136	DI	Diazinon	0.1	0.0911	91.1	
1/20/00	184	170	TR	Prometryn	0.3	0.262	87.3	
				Hexazinone	0.5	0.545	109	
1/20/00	184	169	CB	Carbaryl	0.1	0.107	107	UCL
				Carbofuran	0.2	0.192	96	
1/21/00	183	556	DI	Diazinon	0.2	0.194	97.0	
1/25/00	185	525	TR	Bromacil	0.2	0.178	89	
				Prometon	0.25***	0.253	101	
1/28/00	185	170	TR	Atrazine	0.2	0.194	97.0	
2/1/00	185	171	CB	Carbaryl	0.2	0.209	104.5	UCL
2/3/00	185	294	TR	Simazine	0.2	0.192	96	
2/3/00	185	292	OP	Malathion	0.2	0.182	91.0	
				Chlorpyrifos	0.3	0.266	89	
2/7/00	184	362	TR	Diuron	0.3	0.297	99	
				Cyanazine	0.5	0.489	98	
2/8/00	184	361	OP	Methyl Parathion	0.2	0.201	101	
2/15/00	184	319	DI	Diazinon	0.2	0.192	96.0	
2/19/00	185	293	DI	Diazinon	0.1	0.1	100.0	
2/21/00	184	476	TR	Prometon	0.4	0.435	108.8	
2/22/00	184	475	OP	Phosmet	0.3	0.34	113.3	
2/24/00	184	477	DI	Diazinon	0.2	0.171	85.5	
2/25/00	185	295	TR	Metribuzin	0.5	0.442	88.4	
2/28/00	184	364	OP	Chlorpyrifos	0.3	0.25	83.3	
2/28/00	185	332	TR	Bromacil	0.3	0.294	98.0	
				Atrazine	0.3	0.325	108.3	
2/28/00	184	363	OP	Chlorpyrifos	0.3	0.256	85.3	
3/1/00	185	334	CB	Carbaryl	0.25	0.239	95.6	
3/2/00	185	333	DI	Diazinon	0.2	0.164	82.0	
3/3/00	185	336	OP	Dimethoate	0.2	0.251	125.5	UCL
3/3/00	185	335	CB	Carbofuran	0.35	0.343	98.0	

[a] 184 refers to the study number for the Sacramento River, 185 refers to the SJR.

[b] CL=Control Limit; Upper CL (UCL), Lower CL (LCL). CLs for these pestcides are listed in Tables 3 through 6.

*** Prometon was accidentally spiked at 0.25ppb but was supposed to be 0.5ppb

Table 3. Continuing Quality Control- Organophosphate Screen

Extraction Date	Sample Numbers	Percent Recovery							
		Chlorpyrifos	Diazinon	Dimethoate	Fonofos	Malathion	Methidathion	Methyl Parathion	Phosmet
12/7/99	184- 1, 7, 13 185- 1, 7	87.5	82.5	103	80.0	96.0	100	93.0	83.0
12/10/99	184- 19, 25, 31 185- 13, 19	101	96.3	111	93.0	104	114	107	100
12/14/99	184- 37 185- 25	88.8	85.0	105	86.0	97.0	103	100	91.6
1/13/00	184- 108, 114, 120 185- 79, 85, 169	93.8	90.0	86.0	86.0	103	90.0	107	88.4
1/19/00	184- 126, 132, 137, 143, 149. 185- 91, 97, 103	92.5	88.8	82.0	83.0	108	90.0	108	95.8
1/20/00	184- 155, 161, 167 185- 109, 115	100	96.3	111	93.0	101	120	103	104
1/25/00	184- 175, 181, 185, 191, 197 185- 121, 127, 131, 137	88.8	88.8	102	85.0	92.0	97.0	90.0	91.2
1/27/00	184- 203, 209, 215 185- 140, 143, 149	91.3	87.5	106	66.0	106	120	112	116
2/1/00	184- 221, 227, 231, 237, 243 185- 155, 161, 167	91.3	78.8	99.0	73.0	99.0	109	96.0	95.4
2/3/00	184- 249, 255, 261 185- 176, 182, 292	91.3	91.3	108	89.0	97.0	104	98.0	97.8
2/8/00	184- 267, 273, 279, 285, 361 185- 188, 189, 194, 198, 204	88.8	92.5	98.0	86.0	98.0	108	101	106
2/10/00	184- 291, 297, 303 185- 210, 216	95	93.8	108	85.0	105	111	114	107
2/15/00	184- 309, 315, 320, 326 185- 222, 228, 234	101	98.8	108	96.0	104	112	108	101
2/17/00	184- 338, 344, 350 185- 240, 246	98.8	93.8	113	94.0	110	112	116	103
2/22/00	184- 365, 368, 374, 380, 475 185- 251, 258, 262, 267	98.8	96.3	115	95.0	103	117	112	92.8
2/24/00	184- 386, 392, 398 185- 274, 280	85.0	81.3	105	78.0	92.0	101	93.0	105
2/29/00	184- 363, 364, 404, 411, 417, 423 185- 286, 296, 302	97.5	97.5	103	95.0	105	113	108	95.8
3/1/00	184- 429, 435, 441 185- 308, 314	95.0	93.8	110	89.0	105	112	110	97.2
3/7/00	184- 447, 453; 457, 478, 484 185- 320, 326, 336	105	104	109	104	112	118	112	102
3/9/00	184- 463, 469, 490	96.3	91.3	114	90.0	105	111	103	115
3/14/00	184- 496, 524	97.5	92.5	86.0	93.0	105	111	103	109
Average Recovery		94.9	92.1	103.5	88.9	102.8	108.7	105.2	101.2
Standard Deviation		5.03	5.95	9.88	7.18	5.46	9.06	7.40	7.70
CV		5.30	6.46	9.54	8.07	5.31	8.34	7.03	7.60
Upper Control Limit		116	122	116	102	114	124	116	118
Upper Warning Limit		110	113	110	100	109	116	110	113
Lower Warning Limit		83	78	86	94	87	83	85	95
Lower Control Limit		76	69	80	92	81	75	79	90

*Highlighted cells are percent recoveries exceeding control limits
Study **184** is the dormant season monitoring on the Sacramento River, Study **185** is the dormant season monitoring on the San Joaquin River.

Table 4. Continuing Quality Control-
Carbamate Screen

Extraction Date	Sample Numbers	Percent Recovery Carbofuran	Carbaryl
1/20/00	184- 156, 162, 168, 169 185- 110, 116	87.5	96.0
1/26/00	184- 176, 182, 186, 192, 198 185- 122, 128, 132, 138	82.8	93.4
1/27/00	184- 204, 210, 216 185- 144, 150	92.2	95.7
2/1/00	184- 222, 228, 232, 238, 244 185- 156, 162, 168, 171	73.8	90.8
2/3/00	184- 250, 256, 262 185- 177, 183	81.2	97.0
2/8/00	184- 268, 274, 280, 286 185- 195, 199, 205	90.5	99.2
2/22/00	184- 357, 369, 375, 381 185- 253, 259, 263, 269	74.2	93.0
2/10/00	184- 292, 298, 304 185- 211, 217	98.8	100
2/15/00	184- 310, 316, 321, 327, 333 185- 223, 229, 235	89.4	98.2
2/17/00	184- 339, 345, 351 185- 241, 247	88.8	95.1
2/24/00	184- 387, 393, 399 185- 275, 281	75.0	90.5
2/29/00	184- 405, 412, 418, 424 185- 287, 297, 303	91.0	99.5
3/2/00	184- 430, 436, 442 185- 309, 315, 334	80.1	94.2
3/7/00	184- 448, 454, 458, 479, 485 185- 191, 321, 327, 335	86.2	98.4
3/9/00	184- 464, 470, 491	76.5	93.3
3/13/00	184- 497, 525	83.4	95.0
Average Recovery		84.5	95.6
Standard Deviation		7.33	2.98
CV		8.68	3.11
Upper Control Limit		99.8	99.5
Upper Warning Limit		95.7	96.0
Lower Warning Limit		79.2	82.2
Lower Control Limit		75.0	78.7

Table 5. Continuing Quality Control-
Diazinon Analysis

Extraction Date	Sample Numbers	Percent Recovery Diazinon
12/7/99	184- 3, 9, 15 185- 3, 9	86.5
12/9/99	184- 21, 27, 33 185- 15, 22	91.3
12/14/99	184- 39 185- 27	98.8
1/4/00	184- 45, 51, 57 185- 33, 39	112
1/18/00	184- 128, 133, 136, 139, 145, 151 185- 93, 99, 105	89.1
1/21/00	184- 157, 163, 171 185- 111, 117	91.3
1/25/00	184- 177, 183, 187, 193, 199 185- 123, 129, 133, 139	113
1/27/00	184- 205, 211, 217 185- 145, 151	106
2/3/00	184- 251, 257, 263 185- 178, 184	92.5
2/8/00	184- 269, 275, 281, 287 185- 190, 196, 200, 206	78.8
2/10/00	184- 293, 299, 305 185- 212, 218	97.5
2/15/00	184- 311, 317, 319, 322, 328, 334 185- 224, 230, 236	85.0
2/17/00	184- 340, 346, 352 185- 242, 248, 293 189- 804	92.5
2/22/00	184- 358, 370, 376, 382 185- 254, 260, 264, 270	96.3
2/24/00	184- 388, 394, 400, 477 185- 276, 282	90.0
2/29/00	184- 407, 413, 419, 425 185- 288, 298, 304	102
3/2/00	184- 431, 437, 443 185- 310, 316, 333	80.0
3/9/00	184- 449, 455, 459, 465, 471, 480, 486, 492 185- 322, 328	103
3/14/00	184- 498, 526	91.3
Average Recovery		93.8
Standard Deviation		9.3
CV		9.90
Upper Control Limit		109
Upper Warning Limit		103
Lower Warning Limit		77.6
Lower Control Limit		71.4

*Highlighted cells are percent recoveries exceeding control limits

Study 184 is the dormant season monitoring on the Sacramento River, Study 185 is the dormant season monitoring on the San Joaquin River.

Table 6. Continuing Quality Control- Triazine / Diuron / Bromacil Screen

Extraction Date	Sample Numbers	Percent Recovery								
		Bromacil	Simazine	Atrazine	Diuron	Prometon	Prometryn	Hexazinone	Cyanazine	Metribuzin
12/09/99	184- 6, 12, 18 185- 6, 11	99.8	107.7	73.7	75.4	88.7	85.0	95.9	100.0	86.1
12/13/99	184- 24, 30, 136, 42 185- 18, 24, 30	88.6	93.6	78.3	72.6	83.2	80.1	96.9	91.0	88.0
1/11/00	184- 94, 100, 106, 84, 88 185- 72, 78, 60, 66	88.1	108.2	93.4	90.7	89.2	87.5	93.9	92.1	90.0
1/13/00	184- 113, 119, 125 185- 84, 90	106.3	114.4	113.3	96.6	94.2	100.4	102.3	93.6	87.7
1/18/00	184- 131, 134, 142, 148 154 185- 96, 102, 108	84.0	79.0	97.5	93.8	94.8	99.8	98.8	93.7	103.2
1/20/00	184- 160, 166, 170, 174 185- 114, 120	91.5	95.2	88.2	87.4	94.8	99.8	98.8	93.7	103.2
1/21/00	184- 180, 184 185- 126, 130, 525	80.8	79.9	79.1	85.8	95.8	104.1	117.9	93.5	83.6
1/26/00	184- 19, 196, 202 185- 136, 142	100.5	103.9	92.6	102.1	87.1	102.6	102.5	114.3	102.1
1/27/00	184- 208, 214, 220 185- 148, 159	82.9	81.3	79.8	92.0	97.7	100.1	107.9	95.7	86.1
2/1/00	184- 226, 230, 236, 242, 248 185- 160, 166, 170,	94.0	107.3	88.4	104.8	102.5	108.6	109.4	96.3	92.0
2/3/00	184- 254, 260, 266 185- 181, 187, 295	86.8	87.1	82.2	96.9	74.3	98.1	104.0	96.4	92.8
2/8/00	184- 272, 278, 284, 290, 362 185- 193, 197, 203, 209	89.1	104.4	97.5	110.3	96.8	108.0	94.0	86.8	85.5
2/10/00	184- 296, 302, 308 185- 215, 221	88.4	101.3	81.3	89.3	94.5	108.4	110.1	103.9	93.6
2/15/00	184- 314, 318, 325, 331, 337 185- 227, 233, 239	90.9	93.2	80.7	88.4	93.7	94.6	100.0	91.3	82.7
2/17/00	184- 343, 349, 355 185- 245, 252	91.0	93.2	106.6	100.6	88.1	82.4	100.7	93.5	87.1
2/22/00	184- 367, 373, 379, 385, 476 185- 257, 268, 273	96.6	89.6	117.4	90.3	96.1	93.9	103.4	112.5	99.5
2/24/00	184- 391, 397, 403 185- 279, 285	93.6	105.8	96.3	89.1	106.2	99.3	95.3	93.2	86.4
2/29/00	184- 410, 416, 422, 428 185- 291, 295, 301, 307, 332	93.1	94.8	99.2	90.3	96.6	93.9	119.2	117.2	101.1
3/2/00	184- 434, 440, 446 185- 313, 319	82.1	89.8	82.8	89.2	105.7	100.8	96.3	92.0	94.0
3/7/00	184- 452, 456, 462, 483, 489 185- 325, 329	84.3	98.1	117.6	105.9	89.6	88.8	93.1	88.9	79.8
3/9/00	184- 468, 474, 495	106.7	116.8	109.4	111.0	108.1	92.7	99.6	91.9	89.9
3/14/00	184- 501, 527	91.1	93.4	85.4	94.7	91.1	78.7	93.2	89.8	88.9
Average Recovery		91.1	96.8	94.4	95.5	94.8	97.1	102	96.5	91.5
Standard Deviation		7.26	10.9	12.8	7.78	7.61	8.19	7.63	8.57	7.14
CV		7.97	11.2	13.5	8.15	8.03	8.43	7.48	8.88	7.80
Upper Control Limit		115	126	121	117	111	115	123	121	105
Upper Warning Limit		109	118	114	108	104	108	115	114	101
Lower Warning Limit		86.5	86.4	85.0	74.6	75.9	79.1	84.5	87.4	84.5
Lower Control Limit		80.9	78.5	77.7	66.2	68.9	71.9	76.8	80.7	80.4

*Highlighted cells are percent recoveries exceeding control limits

Study **184** is the dormant season monitoring on the Sacramento River, Study **185** is the dormant season monitoring on the San Joaquin River.

Table 7. Results of sampling at Wadsworth Canal for the Sacramento River Watershed Toxicity Study, Winter 1999-2000. Only pesticides detected at a site during this sampling season are shown.

Table 7 **Wadsworth Canal**

Sampling Date	Diazinon (μg/L)	Methidathion (μg/L)	Carbaryl (μg/L)	Bromacil (μg/L)	Diuron (μg/L)	Hexazinone (μg/L)	Simazine (μg/L)	Measured Discharge (cfs)	Acute Toxicity Percent Survival Sample/Control[1]
12/6/99	nd[2]	nd	nd	nd	nd	nd	nd	66	80/100
12/8/99	nd	nd	nd	nd	0.39	nd	nd	62	100/90
1/3/00	nd	nd	nd	nd	nd	nd	nd	68	100/100
1/5/00	nd	nd	nd	nd	nd	nd	nd	70	95/85[3]
1/10/00	nd	nd	nd	nd	nd	nd	nd	62	90/95
1/12/00	nd	nd	nd	nd	0.116	nd	nd	77	95/100
1/17/00	nd	nd	nd	nd	0.132	nd	nd	99	95/100
1/19/00	nd	nd	nd	nd	0.213	nd	0.137	93	95/100
1/24/00	0.069	nd	nd	0.729	0.85	nd	0.189	157	95/95
1/26/00	0.054	nd	nd	nd	0.072	nd	nd	155	95/100
1/31/00	2.74	1.21	nd	0.141	0.547	0.403	0.319	162	0/100[4]
2/2/00	0.504	0.230	nd	nd	0.053	nd	0.059	117	0/90[4]
2/7/00	0.175	nd	nd	nd	nd	nd	nd	95[5]	50/95[4]
2/9/00	0.193	nd	nd	nd	nd	nd	nd	74[5]	35/100[4]
2/14/00	1.738	0.255	0.0982	0.124	0.217	0.581	0.40	450[5]	0/100[4]
2/16/00	0.541	0.086	nd	nd	0.123	nd	0.384	486	0/100[4]
2/21/00	0.34	0.055	nd	nd	0.078	nd	0.181	258	0/100[4]
2/23/00	0.568	0.116	nd	0.114	0.173	0.253	0.277	679	0/95[4]
2/28/00	0.291	nd	nd	nd	0.096	nd	0.161	600[5]	0/100[4]
3/1/00	0.091	nd	nd	nd	0.062	nd	0.158	299	100/100
3/6/00	0.113	0.067	nd	nd	nd	nd	0.299	464	100/100
3/8/00	nd	nd	nd	nd	nd	nd	0.163	447	100/90

Notes to Table 7:

[1] Two numbers are reported for all toxicity tests. The first number is the result from the sample, the second is the result from the corresponding control. The numbers reported for percent survival refers to the survival at the end of the test.

[2] nd = none detected at the reporting limit for that chemical.

[3] Test failed due to low survival in the control sample. No toxicity is implied by the sample survival results.

[4] The differences in survival between the sample and the corresponding control are statistically significant at $p < 0.05$.

[5] Discharge was not measured due to equipment problems. Historical data based on stage height is presented.

Table 8. Results of Sacramento River Watershed Toxicity Study, Winter 1999-2000 for the Sacramento River at Alamar and the Sutter Bypass at Karnak/Kirkville Road. Only pesticides detected at a site during this sampling season are shown. No other pesticides in the organophosphate, carbamate or herbicide screens were detected.

Table 8	SACRAMENTO RIVER				SUTTER BYPASS				
Sampling Date	Diazinon (μg/L)	Diuron (μg/L)	Chronic Toxicity Percent Survival[1]	Chronic Toxicity Offspring /animal[1]	Site	Diazinon (μg/L)	Bromacil (μg/L)	Diuron (μg/L)	Simazine (μg/L)
12/6/99	nd[2]	nd[2]	-		Karnak	nd	nd	nd	nd
12/8/99	nd	nd	-		Karnak	nd	nd	nd	nd
12/10/99	nd	nd	100/100	38.8/17.7					
1/3/00	nd	nd	-		Karnak	nd	nd	nd	nd
1/5/00	nd	nd	-		Karnak	nd	nd	nd	nd
1/7/00	nd	nd	90/90	27.8/22.3					
1/10/00	nd	nd	-		Karnak	nd	nd	nd	nd
1/12/00	nd	nd	-		Karnak	nd	nd	nd	nd
1/14/00	nd	nd	90/100	15.1/12.5[3]					
1/17/00	nd	nd	-		Karnak	nd	nd	nd	nd
1/19/00	nd	0.164	-		Karnak	nd	nd	nd	nd
1/21/00	nd	0.051	60/80	17.5/30.7					
1/24/00	nd	0.06	-		Karnak	nd	nd	nd	nd
1/26/00	nd	0.215	-		Karnak	nd	0.095	0.112	0.115
1/28/00	nd	0.088	90/90	17.2/15.0					
1/31/00	nd	0.056	-		Karnak	0.043	nd	nd	nd
2/2/00	0.063	0.116	-		Karnak	0.093	nd	0.098	nd
2/4/00	nd	0.092	90/100	15.7/15.2					
2/7/00	nd	0.071	-		Karnak	0.053	nd	0.067	nd
2/9/00	nd	nd	-		Karnak	0.041	nd	nd	nd
2/11/00	nd	0.083	100/70[3]	30.3/16.4					
2/14/00	nd	0.127	-		Kirkvl	nd	nd	nd	nd
2/16/00	0.057	0.14	-		Kirkvl	nd	nd	nd	nd
2/18/00	nd	0.098	100/100	30.2/21.2					
2/21/00	nd	nd	-		Kirkvl	nd	nd	nd	nd
2/23/00	nd	nd	-		Kirkvl	nd	nd	nd	nd
2/25/00	nd	0.06	90/90	31.8/26.3					
2/28/00	nd	0.057	-		Kirkvl	nd	nd	nd	nd
3/1/00	nd	nd	-		Kirkvl	nd	nd	nd	nd
3/3/00	nd	nd	100/90	45.6/46.2					
3/6/00	nd	0.07			Kirkvl	nd	nd	nd	nd
3/8/00	nd	nd			Kirkvl	nd	nd	nd	nd
3/10/00	nd	nd	100/90	24.1/25.0					

Notes to Table 8:

[1] Two numbers are reported for all toxicity tests. The first number is the result from the sample, the second is the result from the corresponding control. Chronic toxicity water was replaced twice each week using new sample water . The numbers reported for percent survival refers to the survival at the end of the test. The number reported for offspring is the number of offspring produced divided by the number of adult animals used in the test.

[2] nd = none detected at the reporting limit for that chemical.

[3] This test is not valid due to a high mortality or a low reproductive endpoint in the control sample.

Figure 1. Map of the Sacramento River Hydrologic Basin.

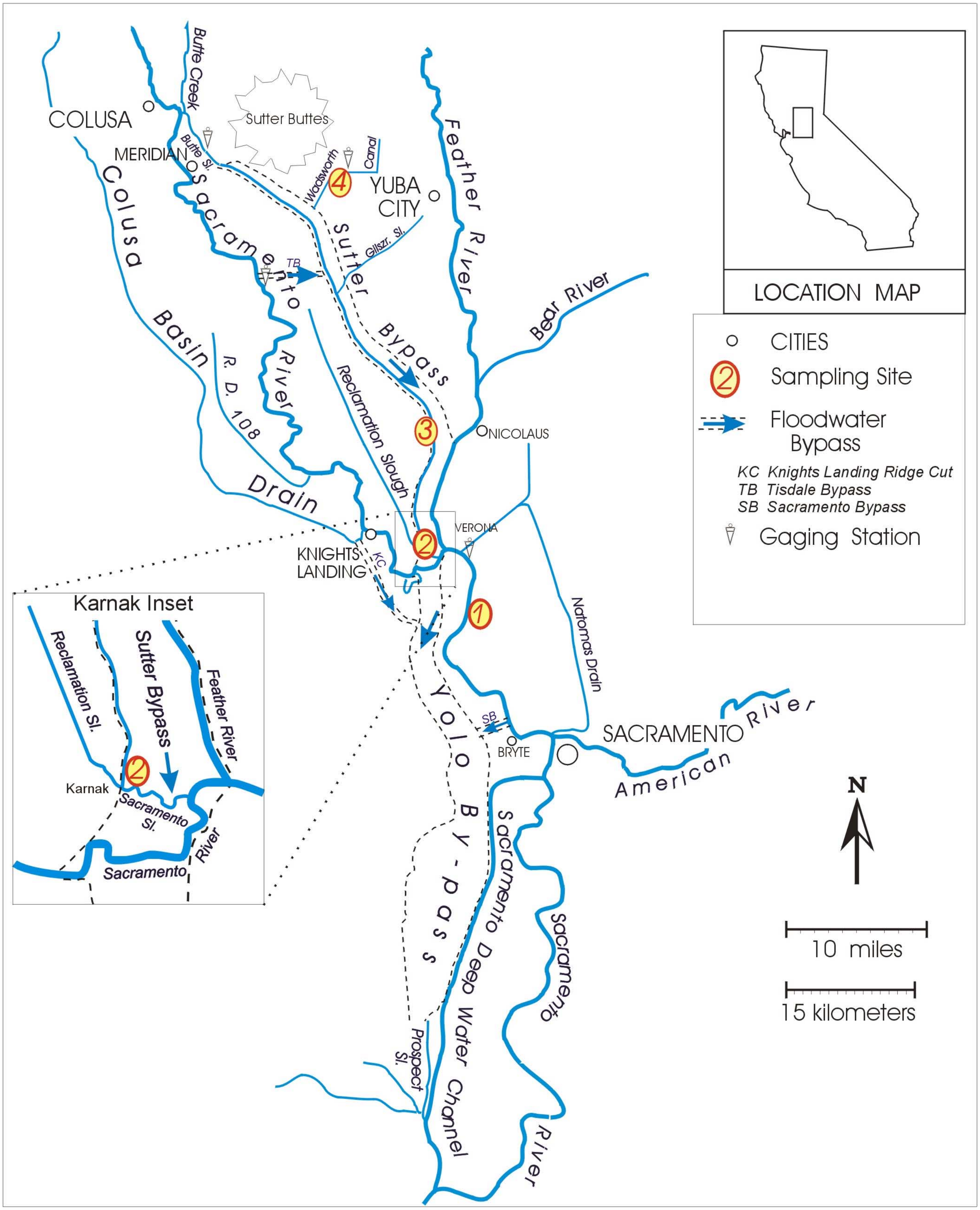


Figure 2: Sampling sites in the Sacramento River watershed.
Site 1 = Alamar Marina, Sacramento River Chronic Toxicity Site.
Site 2 = Sutter Bypass at Karnak Pumping Station, Water Chemistry Site.
Site 3 = Sutter Bypass at Kirkville Road, Alternate Water Chemistry Site.
Site 4 = Wadsworth Canal, Acute Toxicity Monitoring Site.

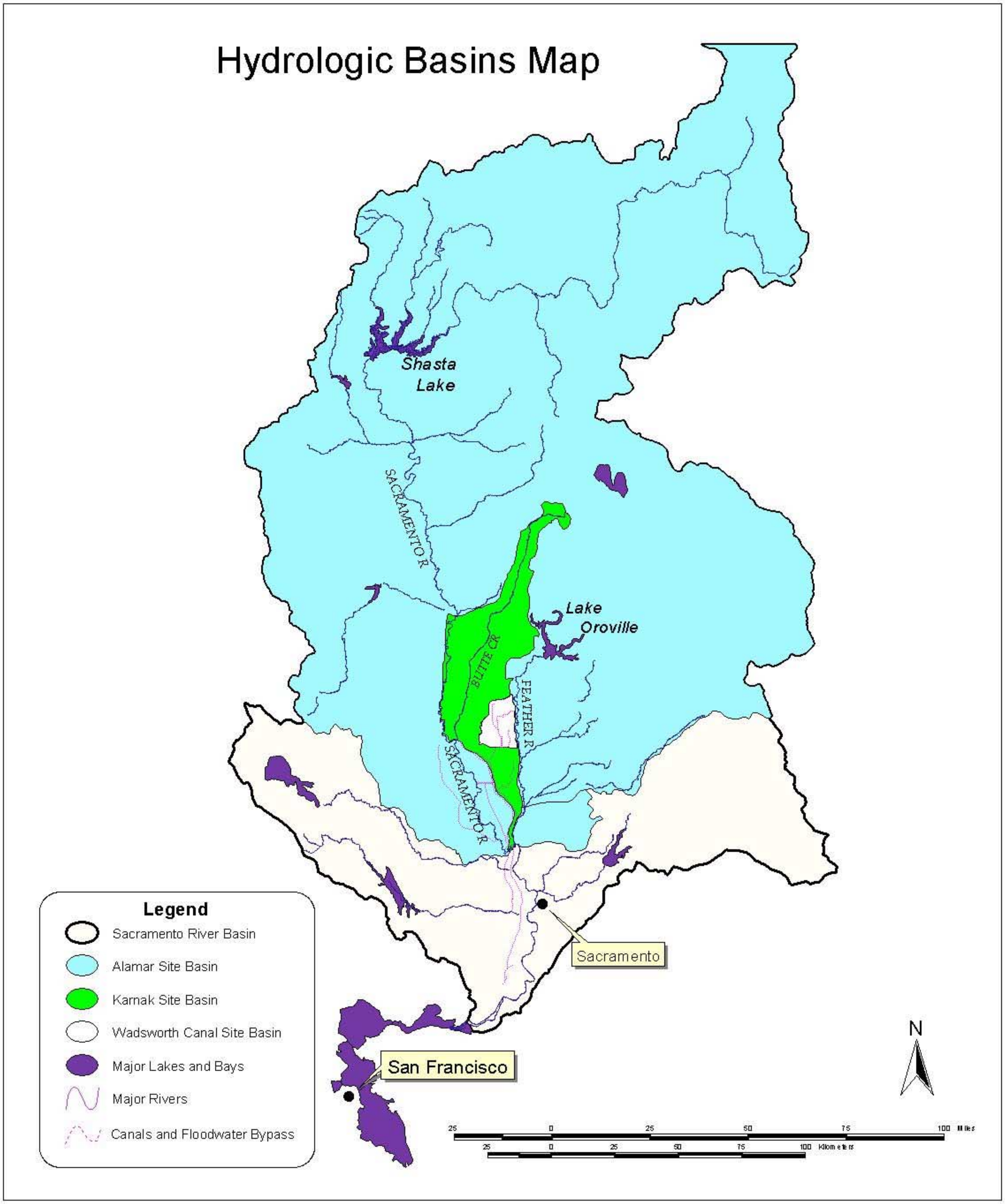
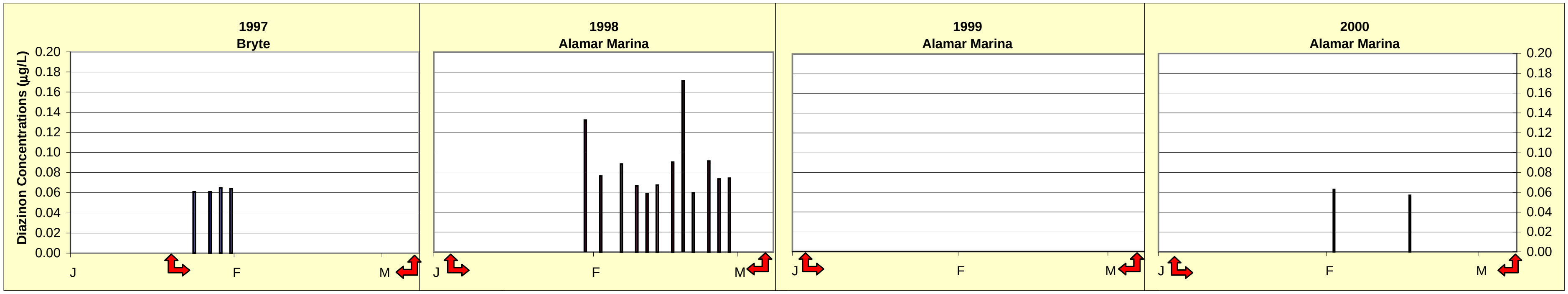


Figure 3. Map of the Hydrologic Basins for the sites used for the 1999-2000 Dormant Spray Monitoring. Each basin includes the area of all the basins listed below it in the legend. When the alternate site at Kirkville Road is used, the hydrologic basin would include large areas of the "Alamar Basin" above Butte Creek due to the influx of Sacramento River water into the Sutter Bypass at Butte Creek and the Tisdale Weir.

DIAZINON DETECTIONS DURING THE DORMANT SPRAY SEASON
SACRAMENTO RIVER



SUTTER BYPASS

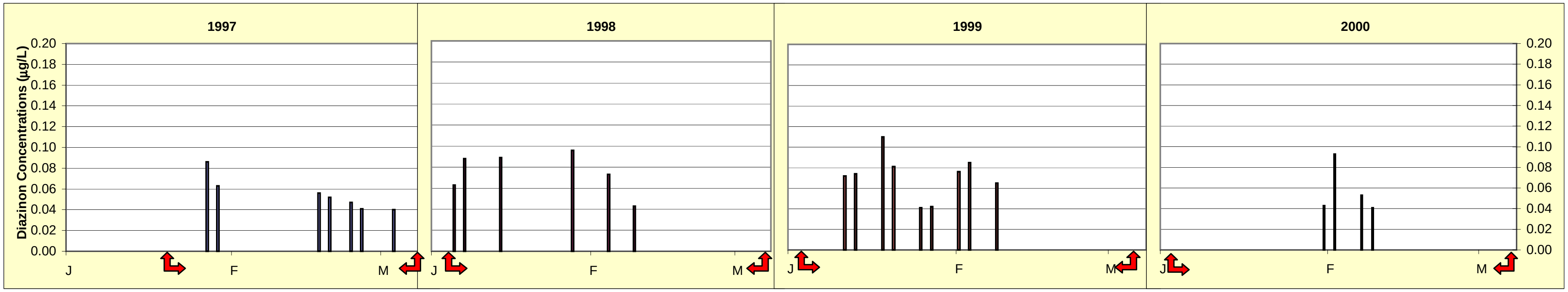


Figure 4. Diazinon detections in the Sacramento River Watershed, January -March, 1997 - 2000. Sutter Bypass samples were collected at either Karnak or Kirkville Road depending on flood conditions.
Note: The reporting limit for diazinon is 0.04 µg/L. Arrows indicate the when sampling began and ceased for a given season. Sampling in 1997 did not commence until January 20 due to severe flooding.

DIAZINON DETECTIONS DURING THE DORMANT SPRAY SEASON
WADSWORTH CANAL

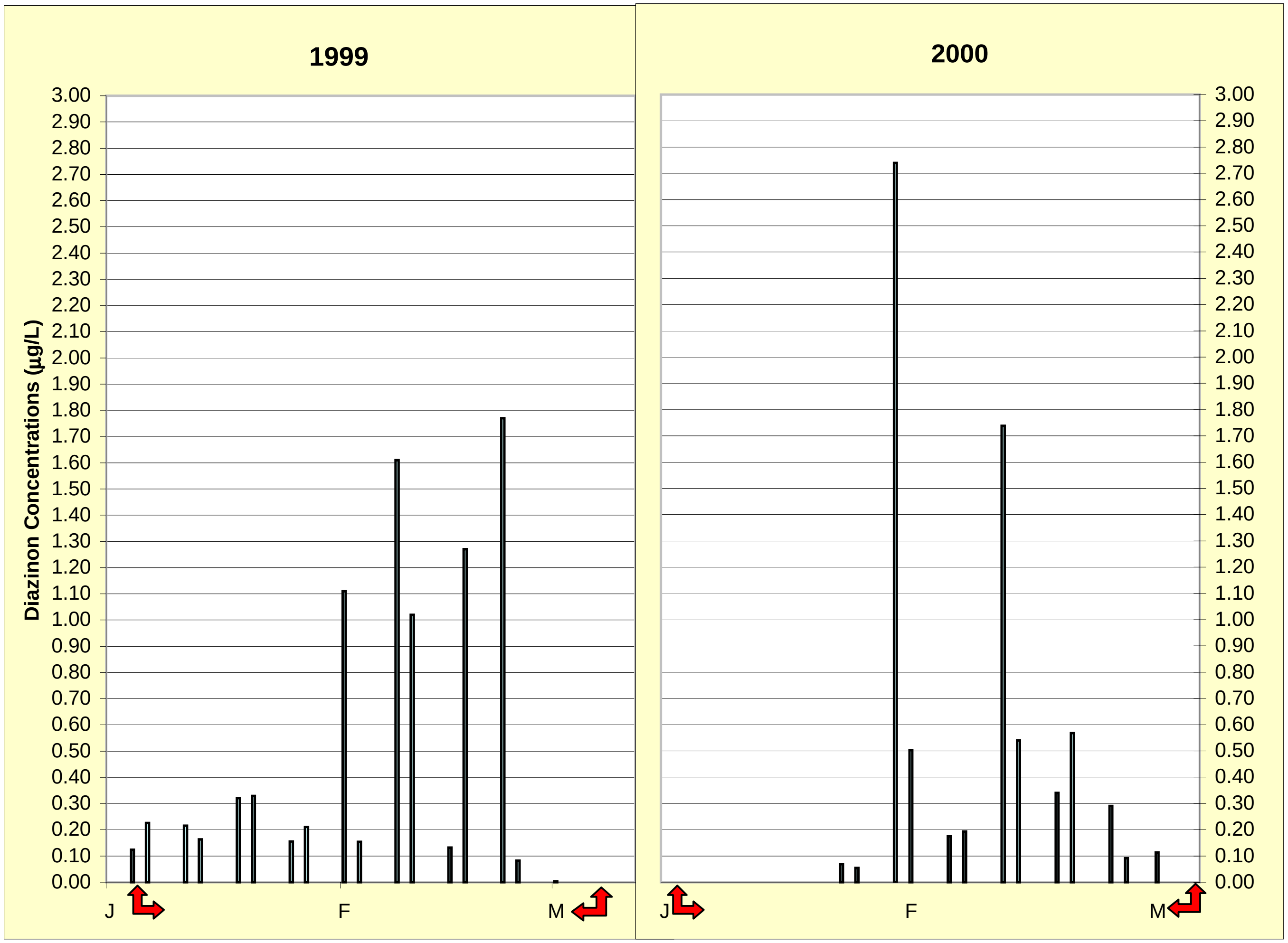


Figure 5. Diazinon detections in the Wadsworth Canal, January - March, 1999 - 2000.
Notes: The reporting limit for diazinon is 0.04 µg/L. Arrows indicate the when sampling began and ceased.
Sampling in 1999 began January 4 and ceased on March 3. Sampling in 2000 began January 3 and ceased March 10.
The scale of these graphs is 15 times that of Figure 4.

ENVIRONMENTAL DATA FOR THE WADSWORTH CANAL, WINTER 1999-2000

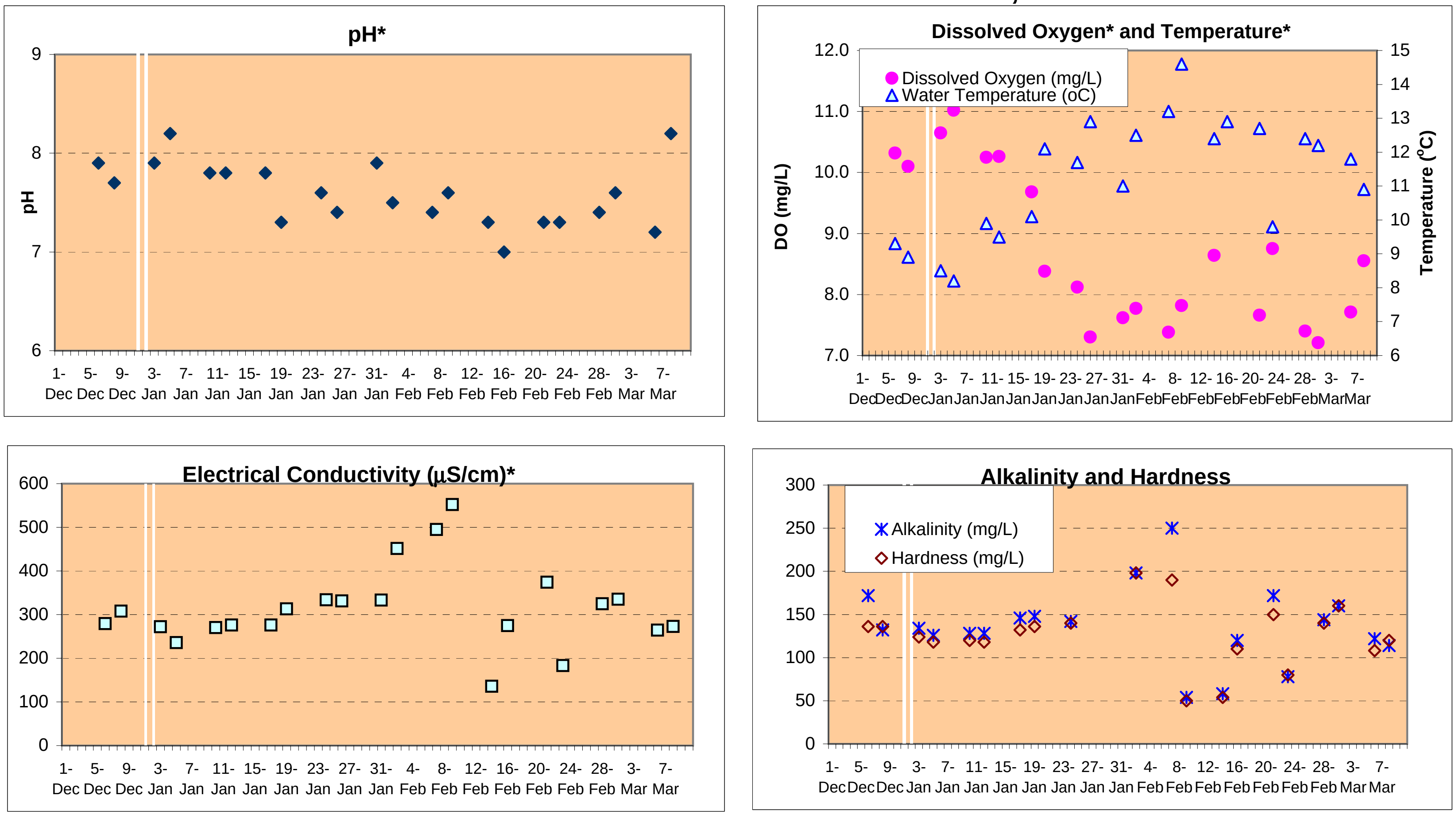


Figure 6. Environmental measurements for the Wadsworth Canal sites. Data was collected from the weir at South Butte Road until February 16, 2000. Measurements were then collected from the bridge at South Butte Road until March 10, 2000. Ammonia levels did not exceed the detection limit of 50 µg/L. Double bar denotes a break in sampling between background and dormant season samples.

***** Denotes measurements made on site.

ENVIRONMENTAL DATA FOR THE SUTTER BYPASS, WINTER 1999-2000

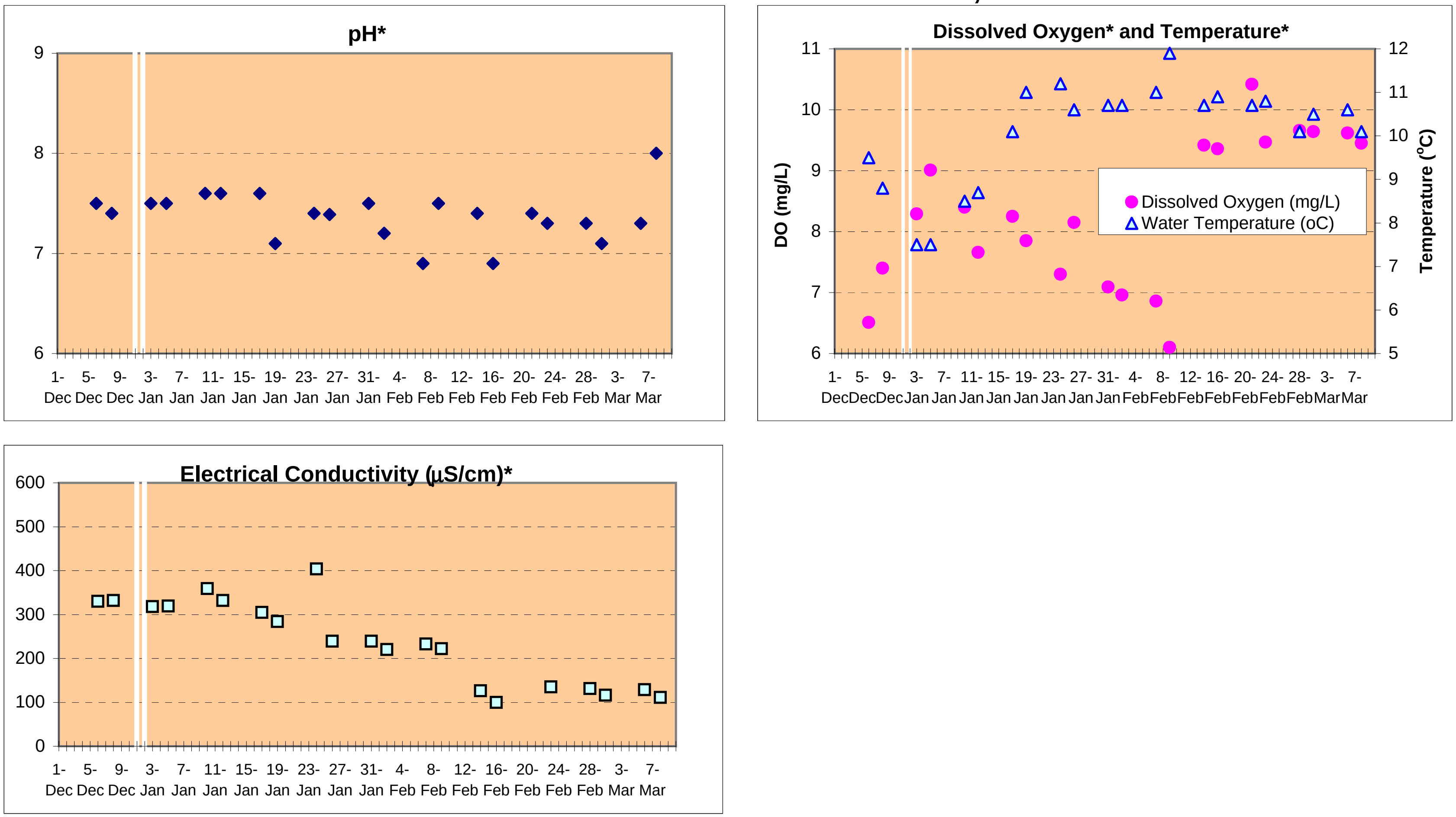


Figure 7. Environmental measurements for the Sutter Bypass taken either at the Karnak or the Kirkville Road sites. Data was collected at Karnak until February 9, measurements were made at Kirkville Road from February 14 through March 10, 2000. Ammonia, alkalinity and hardness were not measured. Double bar denotes a break in sampling between background and dormant season samples. * Denotes measurements made on site.

ENVIRONMENTAL DATA FOR THE SACRAMENTO RIVER, WINTER 1999-2000

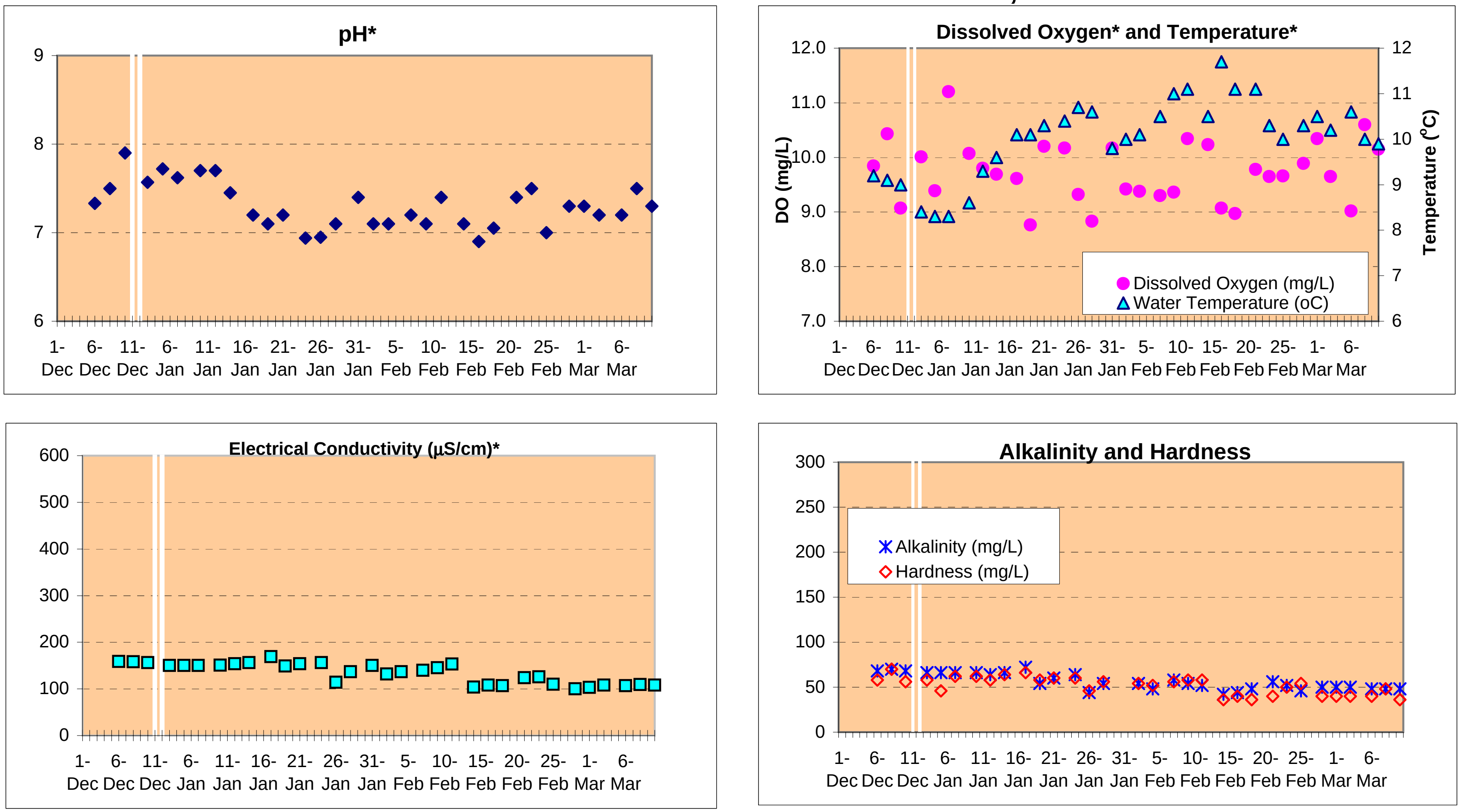


Figure 8. Environmental measurements for the Sacramento River at the Alamar Marina. Data collected from December 6-10, 1999 and January 3-March 10, 2000. Measurements were collected three times per week during the stated period. Ammonia levels did not exceed 50ug/L. * Denotes measurements made on site. Double bar denotes a break in sampling between the background and dormant season samples.

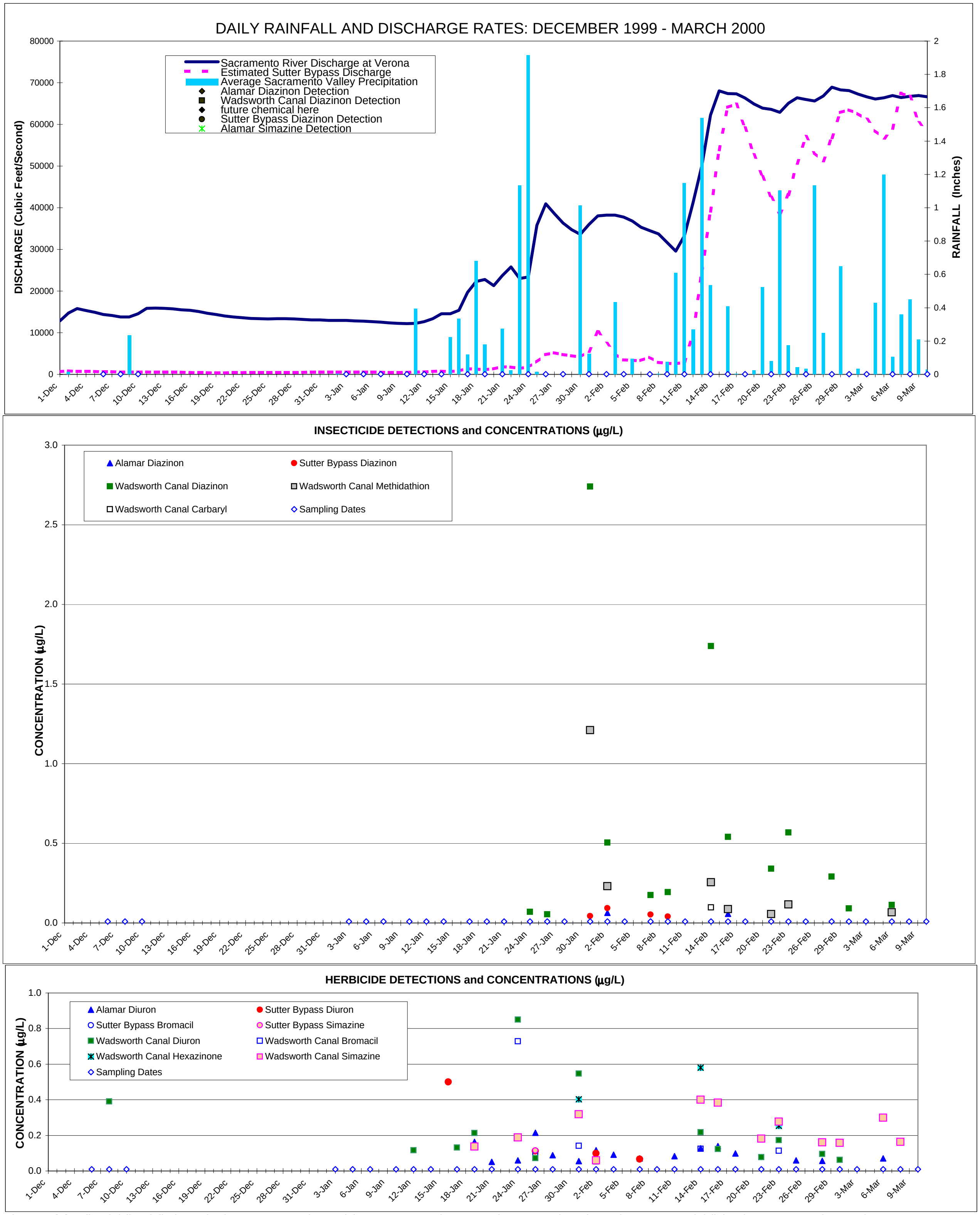


Figure 9. **(A)** Daily rainfall and discharge for the Sacramento River and the Sutter Bypass from December 1, 1999 through March 10, 2000. Rainfall data is an average of two stations in the Sacramento River Basin: Sacramento Post Office and Chico weather stations. Sacramento River discharge was measured at Verona. Sutter Bypass discharge was estimated by adding discharges from the 'Butte Slough near Meridian' and 'Tisdale Bypass' gages. Rainfall and discharge data is provisional and is subject to revision.
(B) Detected insecticide concentrations for the Sacramento River at Alamar, the Sutter Bypass and Wadsworth Canal for the period December 6-10, 1999 and January 3 through March 10, 2000
(C) Detected herbicide concentrations for the Sacramento River at Alamar, the Sutter Bypass and Wadsworth Canal for the period December 6-10, 1999 and January 3 through March 10, 2000
The Wadsworth Canal and Sutter Bypass sites were sampled twice per week (Monday-Wednesday) and the Alamar site was sampled three times per week (Monday-Wednesday-Friday).